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The role of livestock keeping in tuberculosis trends in Arusha, Tanzania

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SUMMARY

SETTING: Arusha, Tanzania.

OBJECTIVE: To assess risk factors that might influence TB control in the general population and in livestock-keepers.

METHODS: Of 242 villages in four districts, 27 were selected randomly. In each village, a general and a livestock-keeping group were selected at random. The households were home-visited and 426 family members were interviewed.

RESULTS: On average, three-quarters of households practised at least one risk activity for transmission of zoonotic tuberculosis, and respondents had poor knowledge about tuberculosis. In the livestock-keeping group, the risks of having a tuberculosis patient in the family were determined by poor ventilation (OR 2.6, 95%CI 1.1–6.5), confining livestock indoors with people (OR 2.3, 95%CI 1.1–5.0) and multiple determinants including poor ventilation (OR 13.5, 95%CI 2.5–71.7). Risk activities and the risks of having a tuberculosis patient in a family were significantly higher in the livestock-keeping group.

CONCLUSIONS: The respondents had limited knowledge about tuberculosis, and the households had practices that posed potential risks for both human and bovine tuberculosis infection. Poor ventilation and confining livestock indoors were associated with tuberculosis spread in the households. These risks were observed more in the livestock-keeping group than in the general population group.

KEY WORDS: livestock; risk; tuberculosis

IN TANZANIA, the notification rate for all forms of tuberculosis (TB) increased from 55 cases/100 000 in 1985 to 169/100 000 in 1999.[1] *Mycobacterium tuberculosis* is recognised as the principal cause of human tuberculosis worldwide. *M. bovis* has also been isolated from some cases of cervical adenitis in Tanzania.[2] However, information on the contribution of *M. bovis* to the current human epidemic has been scarce and it is not clear whether the importance of different risk factors for *M. bovis* infection is widely known.

Transmission of *M. bovis* occurs by direct contact with infected animals, particularly by the respiratory route, as well as by ingestion of infected animal products such as milk.[3,4] Milk-borne infection is thought to be the principal cause of cervical lymphadenopathy (scrofula), and other forms of non-pulmonary tuberculosis.[4] In Tanzania, the potential for zoonotic transmission of *M. bovis* is of particular concern, given that about 77% of the population live in rural areas where livestock keeping is common.[5] Indeed, tuberculosis adenitis has been reported most frequently in Arusha and Mbeya regions, where most of the population are subsistence farmers and livestock keepers.[1] A close physical association between humans and potentially infected animals has been reported in other traditional African communities.[6]

Lack of knowledge about tuberculosis infection and disease in the community may play an important role in delayed diagnosis and treatment of the disease.[7–12] For all forms of tuberculosis, any delay in diagnosis and treatment prolongs the infectious period, and this in turn will increase the number of tuberculosis cases in the community.[13]

Knowledge of underlying perceptions and patterns of tuberculosis might be viewed as constituting a global public good.[14] A community without such understanding will have a compromised ability to avoid an outbreak of the disease. Furthermore, late diagnosis incurs high morbidity and mortality.[15]

This article describes perceptions of tuberculosis in rural communities as well as practices related to livestock keeping and food consumption. The study was conducted in rural and semi-rural areas of Arusha

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METHODS

Design

A cross-sectional study was conducted from January to November 2000 in four rural districts of Arusha Region, Tanzania, in conjunction with a parallel study on cattle tuberculin skin testing. Four hundred and twenty-six households were interviewed about knowledge, attitudes and practices (KAP) in regard to tuberculosis control. Ethical clearance was obtained from the Medical Research Co-ordinating Committee in Tanzania.

Subjects and procedures

A list of villages for each district was obtained at the district headquarters. Using a random table, 27 villages were selected of the 242 villages in four districts; six of 82 villages in Babati, eight of 52 villages in Hanang, seven of 45 villages in Karatu, and six of 63 villages in Mbulu. Although the initial plan was to select six villages from each district, in Hanang and Karatu the estimated group of cattle for tuberculin testing was not reached. This necessitated random selection of additional villages in these districts. The same team conducted both the tuberculin testing and the KAP survey. It was therefore considered cost-effective to conduct the KAP survey in these additional villages also.

A meeting with community leaders was held at village headquarters to discuss the study purpose. The leaders then spent 2 days explaining the study plan and purpose to the people. In each village, two samples were obtained, one from the population as a whole and another from the group of livestock keepers. The general population group was obtained by selecting one ten-cell* leader in each village randomly from the names of the ten-cell leaders obtained from the village chairman. All households under the selected ten-cell leaders were visited for interview regardless of whether they kept livestock or not. The ten-cell leaders had an average of about 12 households.

The livestock-keeping group consisted of livestock keepers who brought cattle in for tuberculin testing. Livestock keepers from all *vitongoji* in the village were requested to bring their cattle for tuberculin testing.† Home visits were made on the day after tuberculin testing. The households under the selected ten-cell leaders and the livestock-keeping group were visited in their homes, where the study was discussed again and verbal consent was obtained to participate in the interview. The family then selected a family member, the head of the household or another older member of the family, for interview depending on their availability during the visit.

Questionnaire

The questionnaire was tested in a separate village, which was not included in the study. Most of the questions were closed with an open option, and some were open-ended.‡ Field workers were trained on how to ask the questions. When necessary, a translator was used to facilitate communication.

The status of milk for consumption was recorded as 'boiled' if both fresh and soured milk types were boiled, and 'not boiled' if one or both types of milk were not boiled. The question on the history of TB in the family depended exclusively on previous hospital diagnosis. The diagnosis of TB in Tanzania usually follows the manual of the National Tuberculosis Control Programme.[16] No attempt was made to differentiate types of TB in the questionnaire. All interviewers were trained to ask about duration of treatment before recording a history of TB. Name, sex and age of patients were also recorded. Three questions relating to other people's beliefs about preparation and consumption of animal products and sharing houses with livestock were asked in the form of a normal conversation after the formal interview. The conversations were held with those who appeared to be willing to give information, as indicated by the relationship established during interview.

Data entry and statistical analysis

During data management, the responses to most questions were re-coded to allow computer entry of responses given in open questions or options and combinations in closed questions. Data were entered and validated in Epi Info version 6,[17] and analysed using SPSS 9.0 for Windows.[18] During analysis the responses to questions on knowledge were re-categorised as 'good' or 'poor', and for ventilation in houses as 'adequate' or 'inadequate' (see Appendix for definitions). Logistic regression was performed to assess and adjust for potential cofounders and interactions for KAP, as specified in the result tables. Pearson ($\chi^2_{(1)}$) and Wald Statistics ($\chi^2_{(2)}$) tests were used to compare group differences for categorical variables. Adjusted odds ratios (OR) with 95% confidence intervals (CI) are reported. The *t*-test was used for comparison of continuous variables. Differences were considered statistically significant if $P \leqslant 0.05$.

Multivariable logistic regression modelling was used to assess risk factors for the presence of a TB patient in a family. The procedure used was backward

* A local village member, selected by the villagers according to guidance given by local government, to represent around ten households in governmental administrative issues.

† A *kitongoji* (singular form of *vitongoji*) is an administrative subdivision of a village. A village will usually have at least three subdivisions.

‡ The questionnaire is available upon request from the authors.

Table 1 Single and modelled multiple risk factors for having tuberculosis in a family

	General population group*				Livestock-keeping group*			
		TB in family				TB in family		
Risk factors	% (*n*)	% (*n*)	OR	95%CI	% (*n*)	% (*n*)	OR	95%CI
Practices								
Uncooked meat/meat products	21.1 (223)	24.1 (29)	1.2	0.5–3.1	11.9 (126)	19.2 (26)	2.1	0.7–6.9
Animals in house	41.3 (189)	53.8 (26)	1.8	0.8–4.2	28.8 (160)	42.9 (35)	2.3	1.1–5.0
Poor ventilation	71.4 (227)	82.1 (28)	2.0	0.7–5.5	63.1 (149)	78.8 (33)	2.6	1.1–6.5
Knowledge								
PTB spread	59.7 (22)	53.3 (30)	0.9	0.7–1.2	60.9 (133)	64.3 (28)	0.9	0.7–1.3
TB adenitis: how it is acquired	95.1 (224)	93.1 (29)	0.9	0.6–1.2	94.6 (130)	100 (28)	1.0	0.7–1.4
Can TB spread from animal to man?	57.6 (229)	53.3 (30)	0.9	0.7–1.2	59.1 (176)	65.7 (35)	1.2	0.9–1.6
How is TB spread from animal to man?	80.8 (219)	75.9 (29)	0.9	0.7–1.2	72.9 (129)	76.0 (25)	0.9	0.6–1.2
TB symptoms	80.0 (215)	66.7 (30)	0.9	0.6–1.1	77.6 (125)	81.5 (27)	0.9	0.6–1.2
Final model								
Multiple risks†			2.0	0.5–7.6			13.5	2.5–71.7

Totals do not add up to 426 owing to missing information or non applicability.
* Adjusted for sex and age.
† After screening with stratification analysis, eight variables were considered in the initial model. Only four variables were considered significant based on P value for likelihood ratio statistic, clinical and epidemiological importance. The variables for knowledge were adjusted for sample type, age and sex to control possible interaction and confounding effect. The final models contained the following variables: poor ventilation, animals in the same house, poor knowledge of TB symptoms and transmission methods. The Model χ^2 for general and livestock-keeping groups were 8.9 (df = 4, P = 0.064) and 21.3 (df = 4, P = 0.0003), respectively.

stepwise selection with removal testing that was based on the probability of the likelihood ratio statistic. The significance level of a likelihood ratio statistic was compared to a cut-off value of 0.1. All variables in Table 1 were entered in the initial model. Four variables that had coefficients with significance levels greater than the cut-off value were removed from the final model. In livestock-keeping group the selection process was stopped when the model χ^2 was $P \leq 0.05$, and when the term in the model had clinical and epidemiological importance.[18] In the general population group, the model χ^2 for all successive models had

Table 2 Demographic distribution of the study population

Sample	General population group % (*n*)	Livestock-keeping group % (*n*)	Total % (*n*)
Sex			
Male	53.5 (146)	46.5 (127)	64.1 (273)
Female	58.2 (89)	41.8 (64)	35.9 (153)
Age (years)			
Mean	37.3; SD 12.8	41.7; SD 14.9	39.3; SD 13.9*
18–40	71.1 (167)	53.4 (102)	63.1 (269)†
41–80	28.9 (68)	46.6 (89)	36.9 (157)
Geographical area			
Babati	23.8 (56)	36.3 (69)	29.4 (125)
Mbulu	22.6 (53)	21.1 (40)	21.9 (93)
Hanang	28.9 (68)	18.9 (36)	24.5 (104)
Karatu	24.7 (58)	23.7 (45)	24.2 (103)
Tribes			
Iraqw	59.6 (140)	69.6 (133)	64.1 (273)
Nyaturu	9.4 (22)	3.1 (6)	6.6 (28)
Barabaig	6.8 (16)	3.7 (7)	5.4 (23)
Fyomi	4.7 (11)	3.7 (7)	4.2 (18)
Rangi	1.2 (3)	3.7 (7)	2.3 (10)
Others‡	18.3 (43)	16.2 (31)	17.4 (74)
Occupations			
Cattle-keeping only	9.0 (21)	20.9 (37)	14.1 (58)§
Farmers¶	14.2 (33)	2.3 (4)	9.0 (37)
Farmers and cattle keepers	73.8 (172)	76.3 (135)	74.9 (307)
Others	3.0 (7)	0.6 (1)	2.0 (8)

Some totals do not add up to 426 owing to missing information.
* Difference 4.4 (95%CI, 1.7–7.0), t = 3.2, P = 0.002.
† $\chi^2_{(1)}$ = 14.1, df = 1, P = 0.001.
‡ Other tribes were from regions that did not neighbour Arusha.
§ $\chi^2_{(2)}$ = 5.2, df = 1, P = 0.023.
¶ Traditional farmers.

Table 3 The percentage of risk practices of eating or drinking animal products

Practices	General population group %*			Livestock-keeping group %*			n
Milk							
Drinking behaviour	Yes	No	n	Yes	No	n	
Fresh or soured	98.2	1.8	224	98.3	1.7	172	396
Drinking cow milk	86.1	13.9	231	93.5	6.5	185	416†
Drinking goat milk	20.8	79.2	216	23.4	76.6	167	383
Boil milk (fresh and soured)	79.6	20.4	221	83.1	16.9	183	404
Frequency	Weekly	Monthly	n	Weekly	Monthly	n	
During wet season	99.4	0.6	169	100	0	147	316
During dry season	74.4	25.6	215	75.3	24.7	166	381
Meat or meat products							
Eating habit	Yes	No	n	Yes	No	n	
Cooked meat/meat products	76.6	23.4	235	62.3	37.7	191	426‡
Eating wild animal meat	34.7	65.3	213	41.7	58.3	84	297
Frequency of eating meat or	Monthly	6-monthly	n	Monthly	6-monthly	n	
meat products	80	20	225	87.3	12.7	166	391
Blood-eating habits	Yes	No	n	Yes	No	n	
Drinking blood	47	53	232	75	25	153	385§
Cooking blood	20.8	79.2	106	16	84	94	200

* The totals do not add up to 426 owing to missing information or non applicability.
† $\chi^2_{(1)} = 5.9$, df = 1, $P = 0.015$.
‡ $\chi^2_{(1)} = 10.3$, df = 1, $P = 0.001$.
§ $\chi^2_{(1)} = 30.1$, df = 1, $P = 0.001$.

a significance level greater than the cut-off value. The model with four variables had a model χ^2 with a value close to the cut-off value and was used for comparison with the model in the livestock-keeping group.

RESULTS

Demographic characteristics

The study comprised 64.1% males and 35.9% females ($n = 426$) with no significant variation between the two groups ($P = 0.35$). The mean age was 37.3 years for the general population group and 41.7 years for the livestock-keeping group with an inter-quartile range of 18–80 years. The mean age was significantly higher in the livestock-keeping group than in the general population group ($t = 3.2$, $P = 0.002$) (Table 2).

Food

The proportions of households drinking milk were 86.1% ($n = 231$) and 93.5% ($n = 185$) in the general and the livestock-keeping groups, respectively (Table 3). Milk was boiled by 81.2% ($n = 404$), and the variation between the two groups was not significant. Of 396 households asked about milk preference,

Table 4 Risk behaviour and practices: housing and contact with animals or animal products

	General group (%)			Livestock group (%)			
Factors	Yes	No	n	Yes	No	n	P
Housing							
Mud and wood	80.0	20.0	210	72.0	28.0	168	0.069
Ventilation	29.3	70.7	232	36.9	63.3	158	0.125
Animals and products							
Animals in same house	41.7	58.3	192	28.5	71.1	173	0.011*
Milking	74.1	25.9	224	97.9	2.1	189	0.001†
Herding cattle	74.4	25.6	223	98.4	1.6	189	0.001‡
Herding goats	74.9	25.1	223	94.5	5.5	183	0.001§
Slaughtering	71.6	28.4	225	98.9	1.1	174	0.001¶
Handling skin	69.8	30.2	222	97.1	2.9	175	0.001#
Hunting	22.1	77.9	213	31.9	68.1	113	0.053
Plaster wall dung/mud	65.5	34.5	220	87.3	12.7	158	0.001**
Moving cow dung	73.1	26.9	216	95.7	4.3	162	0.001††

Totals do not add up to 426 owing to missing information or non applicability.
* $\chi^2_{(1)} = 6.5$.
† $\chi^2_{(1)} = 45.3$.
‡ $\chi^2_{(1)} = 47.1$.
§ $\chi^2_{(1)} = 28.4$.
¶ $\chi^2_{(1)} = 52.8$.
# $\chi^2_{(1)} = 49.1$.
** $\chi^2_{(1)} = 23.2$.
†† $\chi^2_{(1)} = 32.9$.

Table 5 Distribution of respondents with poor knowledge about tuberculosis

Knowledge	General population group % (*n*)	Livestock-keeping group % (*n*)	% (*n*)*
TB—what is it?	55.5 (227)	73.2 (142)	62.3 (369)†
TB cause	95.6 (228)	95.1 (143)	95.4 (371)
TB types	56.3 (229)	59.0 (139)	57.3 (368)
PTB spread; ways	59.7 (231)	61.3 (142)	60.3 (373)
Can TB spread: man to man	56.1 (221)	51.6 (124)	54.5 (345)
TB spread: man to man; ways	55.9 (220)	51.6 (124)	54.4 (344)
Can TB spread: animal to man	57.4 (249)	59.7 (191)	58.5 (426)
TB adenitis spread; ways	95.2 (229)	95.0 (139)	95.1 (368)
TB animal to man; ways	80.8 (224)	72.7 (139)	77.7 (363)
TB symptoms; PTB	89.0 (227)	92.7 (137)	90.4 (364)
TB symptoms; EPTB	80.4 (219)	78.5 (135)	79.7 (354)
TB risks for disease	98.7 (227)	100 (126)	99.2 (353)
TB treatability	9.1 (236)	11.8 (144)	10.1 (376)
TB treatment in medical facilities	6.1 (229)	7.9 (126)	6.8 (355)
TB prevention	95.6 (227)	98.5 (133)	96.7 (360)

* Totals do not add up to 426 owing to missing information or non applicability.
† $\chi^2_{(2)} = 8.6$, df = 1, $P = 0.003$.
Wald statistics adjusted for sex and age.

98.2% preferred fresh or soured milk, or both. The preference for milk type did not differ between the two groups ($\chi^2_{(1)} = 0.3$, df = 3, $P = 0.965$).

Uncooked meat or meat products were eaten more by livestock keepers (37.7%, n = 191) than by the general population (23.4%, n = 235) and the difference was significant ($\chi^2_{(1)} = 10.3$, df = 1, $P = 0.001$). Meat or meat products were eaten at least monthly by 83.1% of respondents (n = 391), with no significant variation between the two groups. Blood drinking was practised by significantly more households ($\chi^2_{(1)} = 30.1$, df = 1, $P = 0.001$) in the livestock-keeping group (75%, n = 153) than in the general population group (47%, n = 232). Uncooked blood was consumed by 81.5% of respondents, with no significant difference between the groups.

Housing and handling animals and their products

The distribution of activities linked to housing and handling animals is shown in Table 4. Houses with inadequate ventilation were observed in 67.7% of 390 households; there was no significant difference between the groups. There was, however, a significant difference in the proportion of households where animals were confined in the house with the family, with 41.7% (n = 192) in the general population group and 28.9% (n = 173) in the livestock-keeping group ($\chi^2_{(1)} = 6.5$, df = 1, $P = 0.011$). On average, three-quarters of households in the study population reported practising at least one activity considered at risk for transmission of zoonotic TB. These activities were mainly related to handling animals and animal products, and included milking, herding cattle, herding goats, slaughtering, handling skin, hunting, plastering walls with dung or mud and moving cow dung. These activities were practised significantly more often in the livestock-keeping group.

Knowledge

Table 5 shows the distribution of levels of knowledge about tuberculosis in the general and the livestock-keeping groups. On average, 75% of respondents had poor knowledge of the disease in both groups. Significantly more respondents in the livestock-keeping group (73.2% n = 142) than in the general population group (55.5%, n = 227) responded poorly to the question 'what is tuberculosis?' ($\chi^2_{(2)} = 8.6$, df = 1, P = 0.003). However, most people (89.9%, n = 376) were aware that tuberculosis is treatable and that the disease could be treated at hospital (93.2%, n = 355). There was no significant variation in awareness between the groups.

Beliefs

The distribution of potential beliefs that may weaken TB control strategies is shown in Table 6. The main reasons why several individuals preferred traditional medicine to medical facilities were ignorance,* trust in traditional facilities, mistrust of medical facilities and poverty. All these together ('other' category) accounted for 78.3% (170/217), while cultural beliefs† accounted for 21.7 %. The variation between the two groups was not significantly different.

The preference for unboiled milk was mainly due to perceptions about reduced milk quality and calf's health (41.2%, n = 51) and other beliefs (58.8%, n = 51). 'Other' beliefs included customs, ignorance about the risks and the belief that boiling milk was time consuming. The proportions in the two groups

* They did not know what they were suffering from, were not aware of the benefit of medical facilities, were influenced by others in the community, or felt that it was a waste of time visiting medical facilities.
† Traditional healers were able to treat the disease, witchcraft was more powerful, and if you were seen in hospital you might die.

Table 6 Distribution of beliefs about TB that prevented the population from accepting TB control strategies

Beliefs	General population group % (*n*)	Livestock-keeping group % (*n*)	Totals* % (*n*)
Preference for traditional facilities			
Culture†	23.2 (41)	15.0 (6)	21.7 (47)
Other beliefs‡	76.8 (136)	85.0 (34)	78.3 (170)
Preference for unboiled milk			
Effect on calves§	44.0 (11)	38.5 (10)	41.2 (21)
Other¶	56.0 (14)	61.5 (16)	58.8 (30)
Uncooked meat product			
Quality of meat,# medicine** and taste	80.0 (20)	53.8 (14)	66.7 (34)††
Other‡‡	20.0 (5)	46.2 (12)	33.3 (17)
Livestock in same house			
Safety	52.6 (10)	96.0 (24)	77.3 (34)§§
Other¶¶	47.4 (9)	4.0 (1)	22.7 (10)

* A small sample was questioned about their beliefs; the totals for the variables represent all individuals interviewed for the respective beliefs.
† Traditional healers were able to treat the disease, witchcraft was more powerful, and if you were seen in hospital you might die.
‡ Other beliefs = ignorance (they did not know what they were suffering from, were not aware of the benefit of medical facilities, were influenced by others in the community, or felt that it was a waste of time visiting medical facilities), trust in traditional medicine, mistrust of medical facilities, poverty (traditional medicine is cheap, they could not pay medical bills).
§ Boiling will destroy milk taste, unboiled milk provides energy with fat, boiling milk will destroy butter, and it is believed that calves will die if their mother's milk is boiled.
¶ Habit (customs), ignorance about risks, boiling milk is time consuming.
# Cooking destroys the quality of meat or blood (good taste when eaten with blood, an appetiser), uncooked blood provides high nutrients including haemoglobin, gives more power; uncooked blood gives more energy.
** Like *qansa* or *sanka*, it is medicine for fever, diarrhoea, vomiting, and also for appetite.
†† $\chi^2_{(2)}$ = 6.5 df = 1, P = 0.011.
‡‡ Other= habit (custom), few diseases in the past.
§§ $\chi^2_{(2)}$ = 5.6, df = 1, P = 0.018.
¶¶ Other = traditional practice, for more milk production, to avoid stress, to heat the house, ignorance about risks.

did not vary significantly. More respondents (80.0%, n = 20) in the general group than in the livestock group (53.8%, n = 14) thought the reasons why other people preferred uncooked meat or meat products were because cooking destroyed the quality and taste of meat or meat products. They also believed blood mixed with raw intestinal contents and liver could be used as a medicine (*qansa* or *sanka*) or an appetiser. Those who gave other reasons were 20.0% (n = 5) and 46.2% (n = 12) in the general and the livestock-keeper groups, respectively. The variation between the two groups was significant ($\chi^2_{(2)}$ = 6.5, df = 1, P = 0.011). In both groups people kept animals in the house at night mainly to protect them from theft and wild animals (77.3%, n = 44). This occurred in a significantly higher proportion (96%) in the livestock-keeping group than in the general population group (52.6%) ($\chi^2_{(2)}$ = 5.6, df = 1, P = 0.018).

Risk determinants of tuberculosis in a family

The risk determinants of having a TB patient in a family are shown in Table 1. Only two risk determinants were statistically significant: confining livestock in the house with the family (OR = 1.8, 95%CI 1.1–3.2) and inadequate ventilation (OR 2.1, 95%CI 1.1–4.2). The risk of TB in the family when sharing houses with livestock was higher in the livestock-keeping group (OR 2.3, 95%CI 1.1–5.0) than in the general population group (OR 1.8, 95%CI 1.0–4.2). The risk of TB when ventilation was poor was higher in the livestock-keeping group (OR 2.6, 95%CI 1.1–6.5) than in the general population group (OR 2.0, 95%CI 0.7–5.5). On a multiple risks assessment, the overall risk of poor ventilation was significantly increased to 4.1 (95%CI 1.5–11.6; Model χ^2 20.13, df = 3, P = 0.0002). The multiple risk was higher in the livestock-keeping group (OR 13.5, 95%CI 2.5–71.7) than in the general population group (OR 2.0, 95%CI 0.5–7.6).

DISCUSSION

Our findings indicate that most families consumed fresh or soured milk regularly throughout the year and that most people boiled milk before use. Information about the need for boiling milk is generally given at Mother and Child Clinics and when people attend primary health care facilities. It is also possible that boiling milk was over-reported in this study because people might have been aware that the practice is advised. These findings are similar to those of Walshe et al., who reported that about 90% of milk is consumed fresh or soured in sub-Saharan Africa, and that *M. bovis* is generally destroyed by boiling or during the souring process.[19] However, *M. bovis* has been found to persist in soured milk for up to 14 days.[20] *M.*

bovis and *M. tuberculosis* have been found in milk samples in Nigeria,[21] while a study of 805 raw milk samples from Tanzania showed that 31 (3.9%) of the samples were positive for mycobacteria.[22]

Consumption of meat, offal and blood was widespread, with some variation between livestock-keepers and the population as a whole. Regarding both groups overall, about a quarter of the families had practised at least one of the habits considered to pose a risk for transmission of mycobacteria as well as other zoonotic pathogens, such as brucellosis, salmonellosis and listeriosis. These habits include consuming unboiled milk, and uncooked blood, meat and meat products. The potential risk of mycobacterial transmission by this means is also reported by other studies.[3,4]

Blood is generally consumed during the auction markets, which are usually held once a month. Cultural and customs issues related to eating uncooked meat or blood are difficult to alter. An investigation on a proper approach for dissemination of public health education to this particular community can probably do this.

The livestock-related activities reported in this study, and especially in the livestock-keeping group, pose a potential risk for transmission of *M. bovis* infection via aerosol spread or as a consequence of bacterial excretion in faeces, urine and milk of infected cattle.[23]

Among the respondents' misconceptions regarding the main route of tuberculosis transmission were sharing utensils, smoking and sharing cigarettes, drinking alcohol together, sex, and from dust. This compares with other studies, mostly from developing countries.[8,24–29] Lack of knowledge about the different manifestations of tuberculosis may delay diagnosis and treatment and result in further spread of disease within the community, as shown by some studies.[7,27] In Tanzania, TB services are free,[16,30] but in other countries delays in diagnosis may be associated with fear of medical costs and dissatisfaction with care provided.[25,26]

A further concern is related to the relative lack of knowledge amongst livestock keepers compared to the general population. Semi-nomadic practices may provide an explanation for low levels of public health awareness, as families of livestock keepers may not be able to attend primary health care facilities as regularly as permanently settled families. Whatever the underlying cause, there is a clear case to be made for improving dissemination of public health information to the livestock-keeping segment of the community.

Nevertheless, it was widely recognised that tuberculosis is a treatable disease and that treatment was available at the medical centres. In Tanzania, about 93% of the population lives within 10 km of a health facility.[31] This infrastructure has made it possible for tuberculosis control services to be conducted countrywide, with the district as the unit of implementation. Tuberculosis diagnosis and treatment units are decentralised to the health centres and dispensaries in the districts, and the easy accessibility of health services could thus explain why most tuberculosis patients preferred medical facilities in this study.[31] These results are encouraging, in that relatively less effort to disseminate messages about the availability and accessibility of treatment centres is required.

Sleeping in the same house with animals and poor ventilation were determinants of the presence of a tuberculosis patient in a household. The risk of TB in family due to poor ventilation in the livestock-keeping group was remarkably increased when multiple risk factors were considered.

The possibility of over- or underestimating previously treated TB patients in a family was very limited. A full course of tuberculosis treatment takes at least 8 months, and in some places up to 12 months. It is unlikely that family members would have forgotten if someone in the family had been treated for 8 months. It is also not easy to confuse a treated TB patient for a different disease. It is important to note that all forms of TB were considered as a single type to reduce confusion among interviewees. The local people, especially those with low education, may have had problems in differentiating between the various types of TB.

The proportion of households in which animals were confined in the house with families was higher in the general population than in the livestock-keeping group. It is more likely for families in the general population group to have fewer livestock than the livestock-keeping group, and such families tend to confine them in their houses. Despite this, a higher risk of tuberculosis, mainly due to inadequate ventilation and confining livestock in the same family house, was observed in the livestock-keeping group. The families in the livestock-keeping group are more likely to have big herds of cattle. Our cattle study in the same area shows that a higher proportion of tuberculin-positive reactor cattle were from the large herds. The herds usually graze away from home and sometimes search very far for green pastures. Because of increased contact with other herds and wild animals, the chances of being infected may be higher than in the general population group. Other factors may also be operating within the livestock-keeping group. This is an area for further research.

Nevertheless, the inadequate ventilation and confining of livestock in the same family house might play a major role in tuberculosis transmission in this area. Lack of ventilation could also enhance aerosol transmission of *M. tuberculosis* as well as *M. bovis* from cattle to cattle or from cattle to humans. The finding that keeping livestock in the house at night is also a risk factor for TB suggests a zoonotic component of transmission. Close proximity in combination with a poorly ventilated environment may be a risk for occurrence of animal-to-human aerosol transmission.

It is wise to consider the implications of some problems encountered during the survey. In many African cultures, it is common for the family itself to choose someone to talk to a visitor, and often an adult male is selected, thus accounting for the male dominance observed in our study. The variation of the age distribution observed in the two groups could be accounted for by different characteristics operating within the groups. Adults would more often take responsibility for issues such as interviews concerning their livestock. In addition, in selection of the livestock-keeping group the principle of random selection was only applied at the village level. The principle could not be extended to ten-cell leaders, because lists of households for cattle keepers were not available.

CONCLUSIONS

A greater proportion of respondents representing livestock-keeping families had poor knowledge of TB and practised habits that are potential risks for both human and bovine tuberculosis infection than respondents representing families in the general population. The respondents also had beliefs that undermine TB control strategies. Poor ventilation and confining livestock indoors were associated with tuberculosis spread in the households. The association might suggest occurrence of animal-to-human aerosol transmission, and could be the main route of zoonotic transmission in this community. The families in the livestock-keeping group were at higher risk than in the general population group.

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APPENDIX

Definitions of variables used to assess knowledge of tuberculosis

Variables	Good knowledge	Poor knowledge
What is TB?	Cough for >3 weeks in combination with any other symptoms of tuberculosis mentioned	Only one symptom of tuberculosis other than cough, symptoms not related to tuberculosis or don't know
TB types (identifying the infectious type was given priority)	Pulmonary tuberculosis, or pulmonary tuberculosis with other types of tuberculosis	Other tuberculosis types without pulmonary tuberculosis, don't know
Pulmonary tuberculosis spread: ways	Aerogenous route alone or in combination with other correct possibilities	Other possibilities without aerogenous route and completely incorrect ways
TB spread man to man	Aerogenous route alone	Other ways
Acquiring TB adenitis: ways	Unboiled milk, uncooked meat or meat product or combinations	Don't know
Tuberculosis spread animal to man: ways	Unboiled milk alone or in combination with uncooked meat or meat products, sleeping with animals	Other combinations, incorrect ways, don't know
Tuberculosis symptoms, pulmonary	At least cough for >3 weeks and two other tuberculosis symptoms	Other incorrect and non-pulmonary tuberculosis symptoms
Tuberculosis symptoms; extra-pulmonary	Neck, axillary or inguinal swelling, swelling with constitutional symptoms or other EPTB sites	Other incorrect responses, don't know
Tuberculosis risks for disease development	At least two risk factors for developing tuberculosis disease	One or incorrect risk factors, don't know
Is tuberculosis treatable?	Yes, tuberculosis is treatable	Any other response
TB treatment facilities: medical vs. traditional	Medical facilities	Any other facilities
TB prevention	Early case-finding and treatment with other correct prevention precautions	Other incorrect methods of prevention
Variable for ventilation	Adequate houses with windows	Inadequate houses with apertures or without windows

RÉSUMÉ

CADRE : Arusha, Tanzanie.

OBJECTIF : Déterminer les facteurs de risque qui pourraient influencer la lutte antituberculeuse dans la population générale et chez les détenteurs de bétail.

MÉTHODES : On a sélectionné au hasard 27 villages parmi 242 villages de quatre districts. Dans chaque village, on a sélectionné au hasard un groupe général et un groupe de détenteurs de bétail. Les familles ont été visitées à domicile et l'on a interviewé 426 membres de ces familles.

RÉSULTATS : En moyenne, trois quarts des ménages se livraient au moins à une activité comportant un risque de la transmission de la tuberculose d'origine animale et les répondeurs avaient une faible connaissance de la tuberculose. Dans le groupe « détenteur de bétail », les risques d'avoir un patient tuberculeux dans la famille étaient provoqués par une piètre ventilation (OR 2,62 ; IC95% 1,05–6,53), le confinement des gens à l'intérieur avec le bétail (OR 2,27 ; IC95% 1,04–4,98) et par des déterminants multiples incluant une piètre ventilation (OR 13,45 ; IC95% 2,52–71,70). La part des comportements et les risques d'avoir un patient tuberculeux dans une famille ont été significativement plus élevés dans le groupe détenteur de bétail.

CONCLUSIONS : Les répondeurs n'ont qu'une connaissance limitée de la tuberculose et les familles ont des comportements entraînant des risques potentiels d'infection tuberculeuse à la fois d'origine humaine et bovine. Une mauvaise ventilation et le confinement à l'intérieur avec le bétail sont associés avec la dispersion de la tuberculose dans les familles. Ces risques ont été observés plus souvent dans le groupe « détenteur de bétail » que dans le groupe « population générale ».

RESUMEN

MARCO DE REFERENCIA: Arusha, Tanzania.

OBJETIVO: Evaluar los factores de riesgo que pueden influir sobre el control de la tuberculosis en la población general y en los ganaderos.

MÉTODOS: Se seleccionaron al azar 27 aldeas entre 242, en cuatro distritos. En cada aldea se seleccionó al azar un grupo general y un grupo de ganaderos. Las familias fueron visitadas a domicilio y se entrevistaron 426 miembros de estas familias.

RESULTADOS: En promedio, tres cuartos de las familias practicaban por lo menos una actividad a riesgo para la transmisión de la tuberculosis zoonótica y los participantes tenían escasos conocimientos sobre la tuberculosis. En el grupo de ganaderos, los riesgos de tener un paciente tuberculoso en la familia estaban determinados por una escasa ventilación (OR 2,62, IC95% 1,05–6,53), el confinamiento de las personas con los animales al interior de la habitación (OR 2,27, IC95% 1,04–4,98) y determinantes múltiples, incluyendo la escasa ventilación (OR 13,45, IC95% 2,52–71,70). Las probabilidades de prácticas y de riesgo de tener un paciente tuberculoso en la familia eran significativamente más elevadas en el grupo de ganaderos.

CONCLUSIÓN: Los participantes tenían conocimientos escasos sobre la tuberculosis y las familias tenían prácticas que provocaban riesgos potenciales de infección tuberculosa tanto humana como bovina. La escasa ventilación y el confinamiento del ganado al interior de la habitación estaban asociados con la dispersión de la tuberculosis en las familias. Se observó que los riesgos eran más importantes en el grupo de ganaderos que en el grupo de población general.